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(71)Applicant : AGENCY OF IND SCIENCE & TECHNOL
TOMINAGA JUNJI
NAKANO TAKASHI

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(72)Inventor : TOMINAGA JUNJI
NAKANO TAKASHI

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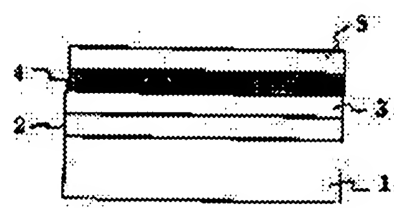
(54) OPTICAL RECORDING METHOD AND OPTICAL RECORDING MEDIUM USING THAT

(57)Abstract:

PROBLEM TO BE SOLVED: To enable high-density recording and reproducing of information by irradiating the surface of a recording layer comprising a material in an amorphous state at a temp. lower than the crystallization temp. with light to produce only crystal cores to record information and reading the difference of optical characteristics between the crystal core and the surrounding amorphous part to reproduce the information.



SOLUTION: An optical recording medium is produced by forming a SiN dielectric layer 3 on a glass substrate 1 having good flatness, and forming a recording layer 4 comprising a GeSbTe alloy, and further forming a SiN dielectric layer 5 thereon. A thin metal layer 2 may be formed between the substrate 1 and the dielectric layer 3 so as to conduct heat produced when the recording layer 4 is fused through the dielectric layer 3 to the metal layer 2 to improve the cooling effect. The recording medium has an amorphous recording layer 4 on a transparent or opaque substrate 1. It is preferable that by irradiating the recording layer 4 with

light, a crystal core having 1 to 50 nm radius on the surface is produced and that the thickness d of the recording layer 4 and the radius r of the crystal core satisfy the relation of d>2r.

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical recording medium using the high density optical recording approach and it in which record of a mark with a radius of 60nm or less and playback are possible.
[0002]
[Description of the Prior Art] In recent years, an optical recording medium attracts attention as a bearer of the central role of the record medium in a highly informative society, research is advanced positively, and, recently, the optical recording medium which can carry out record playback of the information on high density at high speed has come to be used widely, especially using an optical recording method.
[0003] In such an optical recording medium, the phase change method using the difference of the optical property in the amorphous state and crystallized state, for example, the difference of permeability or a reflection factor, is mainly put in practical use already as an optical recording medium of a rewritable mold using the optical MAG method using the interaction of the light and the MAG which are called a car or the Faraday effect, and the alloy containing a chalcogen element.
[0004] On the other hand, the optical recording medium of a write-in method is also already put once in practical use. This thing uses organic coloring matter as a recording layer, disassembles coloring matter with the heat by optical exposure, and records it using the difference of the optical property before and behind that. The recording density of an optical recording medium [such] improves increasingly with the further high advancement in information technology in recent years, and research of DVD-R of rewritable DVD-RAM or a 1-time write-in mold etc. is done briskly.
[0005] ["Jpn.J.Appl.Phys." by which it is considered for the record medium using the optical recording technique by the phase change method to fit densification from the alloy property, and the recording density of 2.6 G bytes or 5.2 G bytes is already attained in the disk of 12cm size in these optical recording media using this, the 35th volume, and the 502nd page (1996) --] .
[0006] moreover, ["Jpn.J.Appl.Phys." as which the optical recording technique which was changed to the crystallized state since the AZUDEPO condition was amorphous, used the difference of the optical property using phase change mold record film, and attained densification further is advocated, the 35th volume, and the 443rd page (1996) --] . Although this optical recording technique is what used approaching space optical recording and it has succeeded in forming the crystal mark of magnitude with a radius of 60-200nm, the grain size of phase change mold record film 60nm or less is not observed. And since this optical recording method made the crystal of GeSbTe form from the AZUDEPO condition that a random condition is large, its activation energy accompanying crystal growth was high, and record power was not enough.
[0007] furthermore, ["Jpn.J.Appl.Phys." by which record to phase change mold record film is tried using the atomic force microscope, the 36th volume, and the 523rd page (1997) --] . And when charge distribution arises with shot key contact on this record film and the chromium coating head of an atomic force microscope, it was pointed out that it can record and it has succeeded in record of the mark it is

[mark] the diameter of about 10nm. However, since the head of an atomic force microscope is used in this case, playback of that record is impossible.
[0008] Thus, in the method which uses light, records information and is reproduced, the actual condition is that the technique in which the optical recording approach and optical recording medium which record a mark with a radius of 60nm or less, and can be reproduced are not found out until now, but it is an optical recording method, and the densification more than TERABAITO can be attained does not exist until now.
[0009]
[Problem(s) to be Solved by the Invention] This invention is the basis of such a situation, and record of a mark with a radius of 60nm or less and playback are possible for it, and it is made for the purpose of offering the optical recording medium using the optical recording approach and it which can record information on high density and can be reproduced.
[0010]
[Means for Solving the Problem] As a result of repeating research wholeheartedly about the optical recording approach which can carry out record playback of the information on high density, this invention persons use a phase change mold record ingredient for a recording layer, and irradiate light on the front face. Based on a header and this knowledge, it came to complete this invention for the ability of said purpose to be attained by generating only a crystalline nucleus from the ingredient of an amorphous state, recording information, reading the difference of the optical property of that crystalline nucleus and surrounding amorphous section, and reproducing information.
[0011] Namely, this invention is below crystallization temperature in the optical recording approach which the optical property of a record medium is changed and records information by the exposure of light. Irradiate light on the front face of the recording layer which consists of an ingredient of an amorphous state, generate only a crystalline nucleus, and information is recorded. In the optical recording medium which has the recording layer which becomes the optical recording approach characterized by reading the difference of the optical property of the crystalline nucleus and surrounding amorphous section, and reproducing information, and a list from the ingredient of an amorphous state on transparence or an opaque substrate The optical recording medium characterized by for a crystalline nucleus with a radius of 1-50nm arising on the front face by the exposure of light, and the radius r of record layer thickness d and a crystalline nucleus filling the relation of $d>2r$ is offered.
[0012]
[Embodiment of the Invention] In this invention, what has the recording layer which consists of a phase change mold record ingredient on transparence or an opaque substrate as an optical recording medium is used. There is especially no limit about the above-mentioned substrate, and if a front face is smooth, transparence and opaque all can be used. An aluminum substrate, a GaAs substrate, etc. are mentioned to what prepared the photo-setting resin layer as such a substrate on plastic plates, such as what is commonly used as a substrate of a phase change mold record medium conventionally, for example, polypropylene, acrylic resin, a polycarbonate, styrene resin, and vinyl chloride system resin, the glass substrate, or the glass substrate, and a pan.
[0013] There is especially no limit as a phase change mold record ingredient which constitutes the recording layer prepared on these substrates, conventionally, a well-known thing, for example, the GeSbTe alloy generally used widely, an Ag-In-Sb-Te alloy with lower crystallization energy, and a crystallization rate can be controlled, and the Ag-In-Sb-Te-V alloy which can check crystal growth is used.
[0014] This recording layer can be formed on a substrate using said phase change mold record ingredient with physical vapor deposition, such as a well-known approach, for example, vacuum deposition, and sputtering, or chemical vapor deposition. Under the present circumstances, said alloy itself may be vapor-deposited as a target, each component of an alloy may be vapor-deposited as a target, and you may alloy on a substrate. Thus, as for the prepared recording layer, it is desirable to carry out the laminating of the heat-conduction protective layer which becomes the top, the bottom, or its both from one layer or a multilayer. The layer which consists of a dielectric which is comparatively easy to

penetrate light as this heat-conduction protective layer is suitable.
[0015] In this invention, the recording layer which did in this way and was prepared on the substrate needs to make it an amorphous state, before recording information. For that purpose, it is advantageous to irradiate laser light again, or to carry out a temperature up to more than the melting point of a recording layer, to cool by ultra high-speed subsequently with heating, and to make an amorphous condition once form from the AZUDEPO condition that a random condition is large, with light or heat, after making a crystallized state carry out phase stabilization.
[0016] Unlike the amorphous condition of being called an AZUDEPO condition, since crystallization energy is lower than an AZUDEPO condition, the amorphous state formed by such approach tends to form a crystalline nucleus, and can fully form a crystalline nucleus also in very low optical power like approaching space optical recording. In the recording layer of such an amorphous state, the activation energy is about 1.4-1.7eV in a GeSbTe alloy recording layer, and crystal transition temperature is about 120-130 degrees C.
[0017] In this invention, in order to realize the above-mentioned rapid cooling temperature change, as for record layer thickness, it is desirable that it is in the range of 10-30nm. Moreover, although there is especially no limit, dielectrics, such as an ingredient with the good conductivity of heat especially SiN, and SiO2, are [that what is necessary is just what has the softening temperature or the melting point more than the melting point of this recording layer as an ingredient which constitutes the heat-conduction protective layer by which a laminating is carried out to one / at least / field of this recording layer by request] suitable.
[0018] Furthermore, a thin metal layer may be formed between a substrate and this dielectric. This is for making a metal layer conduct the heat produced when a recording layer dissolves through a dielectric layer, and raising the cooling effect. About 10-30nm of the thickness of this metal layer is enough. If this metal layer is too thick, light cannot be inputted through a substrate but the sensibility which can detect the optical head which senses the approaching space put on right above [recording layer] or right above [dielectric layer] on a recording layer will fall. Moreover, the dielectric layer thickness prepared in the bottom of a recording layer has the desirable range of 20-300nm, in order to prevent deforming a substrate with the heat generated from a recording layer. If it denaturalizes with heat in less than 20nm when this thickness uses a plastic plate, there is a possibility that record may be impossible and it exceeds 300nm, the effectiveness by interference of light shows up as a noise on an approaching space readout head, and may reduce a signal strength ratio. The dielectric layer thickness prepared on a recording layer on the other hand has desirable 500nm or less. If this thickness exceeds 500nm, spacing of a recording layer and a head will be expanded, the reinforcement of the approaching space (EBANESSENTO place) to generate will decline exponentially, and signal strength will be reduced remarkably.
[0019] In this invention, although irradiate light below at crystallization temperature, the front face of the recording layer which consists of an ingredient of an amorphous state is made to generate only a crystalline nucleus and information is recorded on it, it is required in this case to make magnitude of a record spot into about several nm. For that purpose, minute light opening below the light wave length who uses must be made to approach an approaching space field. In order to create this minute light opening, the approach of using the optical fiber which outgoing radiation opening of the waveguide which introduces light was minimum-ized [optical fiber] below on wavelength, or radicalized the tip in nano meter size etc. is used.
[0020] When using an optical fiber, coating of a metal, for example, gold, silver, aluminum, or these alloys may be carried out to the point by the thickness of hundreds of nm. The laser light source is connected to this optical fiber, and the signal generation equipment in which light modulation is possible is connected. Furthermore, to the point of a fiber, the piezo-electric element of three dimensions has joined together, and a location can be controlled by precision of NANOMETA. Said optical fiber to which generate this optical contiguity place and this is made to read is installed in the recording layer side of an optical recording medium, and is introduced through the dielectric layer which introduced the laser signal into a part of recording layer directly, or was prepared on the recording layer.

[0021] Thus, the light energy of the introduced diameter of NANOMETA forms the crystalline nucleus of nano meter size in the recording layer front face of an amorphous state with the heat which it was absorbed by light or the recording layer and was generated. Since absorb the heat held at the recording layer, without being cooled, and crystal growth arises around this crystalline nucleus, consequently a record mark continues growth to stable size at once and a mark 60nm or more is formed immediately after a crystalline nucleus occurs when the diameter of opening of an optical-fiber point is too large, it becomes unrecordable [TERABAITO]. Moreover, when the diameter of opening of an optical fiber is too small, the laser power of writing falls and formation of a crystalline nucleus decreases remarkably. Therefore, the magnitude of the diameter of opening of an optical fiber has desirable about 10-50nm for a diameter. Thus, information is recorded by irradiating light on the front face of the recording layer which consists of an ingredient of an amorphous state, and generating only a crystalline nucleus as an information signal.
[0022] On the other hand, informational playback carries out incidence of the feeble laser light from the opposite side of the recording layer in an optical recording medium, makes a recording layer penetrate, and is performed by reading the difference of the optical property of the crystalline nucleus in this recording layer, and the amorphous section of the perimeter, for example, the difference of the reflection factor accompanying refractive-index change, or permeability. The readout of the difference of this optical property can form a photodetector in the edge which introduced the laser light of said optical-fiber head, for example, can synchronize the migration location and signal strength of a head, and can be performed by reading an informational write-in location and an informational signal.
[0023] This invention also offers the optical recording medium using the aforementioned optical recording approach again. By this optical recording medium's having the recording layer which consists of an amorphous ingredient on transparence or an opaque substrate, and irradiating light at this recording layer, a crystalline nucleus with a radius of 1-50nm is produced on that front face, and the radius r of this record layer thickness d and a crystalline nucleus fills the relation of $d>2r$. High density record of TERABAITO is possible for such an optical recording medium.
[0024] In this optical recording medium, the heat-conduction protective layer which consists of one layer or a multilayer as mentioned above in a recording layer top, the bottom, or its both can be prepared. Drawing 1 is the cross-section enlarged drawing showing the structure of one example of the optical recording medium of this invention, and shows the structure where the laminating of the metal layer 2, a dielectric layer 3, a recording layer 4, and the dielectric layer 5 was carried out one by one on the substrate 1.
[0025]
[Effect of the Invention] According to the optical recording approach of this invention, record of a mark with a radius of 60nm or less and playback are possible, and the information on TERABAITO can be recorded on an area equivalent to the compact disk of 12cm size.
[0026]
[Example] Next, although an example explains this invention to a detail further, this invention is not limited at all by these examples.
[0027] After forming a SiN layer with a thickness of 100nm on a glass substrate with a thickness [with a sufficient example flat-surface precision] of 1mm, the recording layer which consists of a GeSbTe (atomic ratio 2:2:5) alloy with a thickness of 50nm was formed, the SiN layer with a thickness of 10nm was further formed on this, and the optical recording medium was produced. Vacuum membrane formation equipment performed these actuation continuously altogether. The pressure of membrane formation was set to 0.5Pa, and the SiN layer introduced an argon and nitrogen gas using Si target, and formed membranes by the reactive-sputtering method. The refractive index of the SiN layer in this case was 1.9.
[0028] Next, after heating this record medium to 150 degrees C once exceeding slight crystallization temperature and leaving it for 10 minutes, it checked that cooled to the room temperature and the recording layer had changed to the crystallized state by change of a reflection factor. Subsequently, after irradiating the Ar-ion-laser light of 1W in the shape of a pulse, heating this recording layer to the

temperature exceeding the melting point in an instant and forming a melting condition, it was made to supercool by using the off time amount of a pulse, and phase transition of the recording layer was again carried out from the crystallized state to the amorphous state. It checked that the recording layer was an amorphous state from the difference in a reflection factor after re-phase transition. The reflection factor in this case was higher than the reflection factor of the AZUDEPO condition immediately after producing a record medium, and was a value lower than the reflection factor of said crystallized state. The diameter of opening of the point which coated Au with the thickness of 100nm brought the fiber probe which is 20nm close to this record medium to 150nm, and recorded the signal on it using 200mW Ar-ion-laser light. Under the present circumstances, the probe was made to scan by 20micrometers/second in rate, and the signal was modulated by 1kHz.

[0029] Next, from the opposite side of a recording layer, 1mW Ar-ion-laser light was irradiated, said probe was set by the exposure shaft of this laser light, the probe was made to approach to 150nm at a record medium, and when the recorded part was read, the signal with a radius of 10nm was detectable.

[0030] Next, although the mark which only the crystalline nucleus followed in the shape of a pulse was checked when the record medium which recorded the signal was destroyed and the recording layer was observed with the transmission electron microscope and the atomic force microscope, the crystal did not exist in the perimeter or other location. It is the mimetic diagram of the transmission electron microscope photograph of the recording layer which recorded the signal by this example, and, as for drawing 2 , it turns out that only the crystalline nucleus is generating in the shape of a pulse.

[0031] The optical recording medium was produced like the example example of a comparison, and it was used with the AZUDEPO condition, without heat-treating. The diameter of opening of the point which coated Au with the thickness of 100nm brought the fiber probe which is 20nm close to this record medium to 150nm, and recorded the signal on it using 200mW Ar-ion-laser light. Under the present circumstances, the probe was made to scan by 20micrometers/second in rate, and the signal was modulated by 1kHz.

[0032] Next, from the opposite side of a recording layer, 1mW Ar-ion-laser light was irradiated, said probe was set by the exposure shaft of this laser light, the probe was made to approach to 150nm at a record medium, and it was undetectable when the recorded part was read. Then, when the signal modulation factor was dropped and having been recorded by 200Hz, the mark of the diameter of 100nm was recorded.

[0033] Next, when the record medium which recorded the signal was destroyed and the recording layer was observed with the transmission electron microscope and the atomic force microscope, it was checked that the crystal has grown to be the surroundings of a crystalline nucleus. In this example of a comparison, it is the mimetic diagram of the transmission electron microscope photograph of the recording layer which recorded the signal by 200Hz, and, as for drawing 3 , it turned out that the crystal has grown to be the surroundings of a crystalline nucleus.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The optical recording approach characterized by irradiating light on the front face of the recording layer which consists of an ingredient of an amorphous state, generating only a crystalline nucleus, recording information, reading the difference of the optical property of the crystalline nucleus and surrounding amorphous section, and reproducing information below at crystallization temperature in the optical recording approach which the optical property of a record medium is changed and records information by the exposure of light.
[Claim 2] The optical recording approach according to claim 1 of irradiating light on the surface of a recording layer using the optical waveguide which has a diameter [comparable as a crystalline germ or] of optical opening smaller than it, or an optical fiber, and generating only a crystalline germ.
[Claim 3] The optical recording medium characterized by for a crystalline nucleus with a radius of 1-50nm arising on the front face by the exposure of light, and the radius r of record layer thickness d and a crystalline nucleus filling the relation of $d>2r$ in the optical recording medium which has the recording layer which consists of an ingredient of an amorphous state on transparence or an opaque substrate.
[Claim 4] The optical recording medium according to claim 3 which carried out the laminating of the heat-conduction protective layer which becomes one [at least] field of a recording layer from one layer or a multilayer.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The expanded sectional view of one example of the optical recording medium of this invention.
[Drawing 2] The mimetic diagram of the transmission electron microscope photograph of the recording layer which recorded the signal.
[Drawing 3] The mimetic diagram of the transmission electron microscope photograph of the recording layer which recorded the signal by 200Hz.
[Description of Notations]
1 Substrate
2 Metal Layer
3 Dielectric Layer
4 Recording Layer
5 Dielectric Layer

[Translation done.]

* NOTICES *

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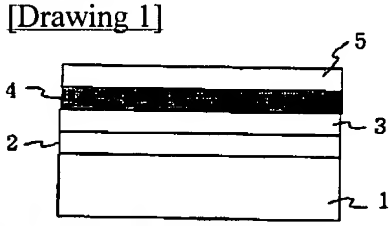
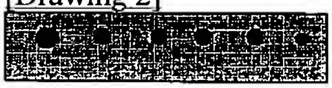
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

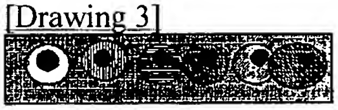
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]